

Theses of Doctoral (PhD) Dissertation

**NEW POSSIBILITIES ON IMPROVEMENT OF
PROPAGATION AND LARVAL NURSING
TECHNOLOGY OF STERLET**

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1. Introduction

1.1. Background

Besides their high importance for natural water bodies, the family of sturgeons (*Acipenseridae*) recently gains more attention for aquaculture production due to diversity of its products, such as black caviar, boneless meat and skin.

Sterlet (*Acipenser ruthenus* L., 1758) is the smallest among sturgeons and is indigenous in the water bodies of Hungary. Already during 1980's the commercial production was established in the Soviet Union, as the caviar of this species was marketed as „carskaya” - Caesarean. From 2000's this species was proposed for production in order to diversify the offer of products next to the, at that time, “traditionally” farmed sturgeons (WILLIOT et al., 2001). Compared to the larger species, the advantage of sterlet lays in simpler handling, earlier sexual maturation and thus the shorter reproductive cycle. Therefore, by 2010 it became the third most cultured sturgeon species in 15 countries including such well-established caviar producing countries such as Russia and Iran (BRONZI et al., 2011).

The common characteristic in sturgeon ovulated eggs is that adhesiveness develops 1-2 minutes upon activation with water. This feature is not acceptable for the procedure of artificial reproduction due to egg clumping and sticking to the walls of the incubating jars, which leads to oxygen depletion, and consequently occurrence of fungal infection in eggs (GISBERT and WILLIOT, 2002). In this way this adhesiveness of eggs may lead to reduced embryo survival upon fertilisation. Upon stripping, the obtained eggs are mixed with ovarian fluid and blood due to injuries. The chemical composition of this fluid may inhibit the fertilisation process. Therefore, it is advised to use either half-dry fertilisation method (DOROSHOV et al, 1983) or, if possible, to wash the eggs prior to fertilisation, known as wet fertilisation method (KOWTAL et al., 1986).

The eggs originating from a single female typically need 2-3 days to finish hatching in case of no human intervention. This long hatching duration leads to various issues for production such as fungal infections, later size variability, cannibalism etc. With respect that artificial hatching takes days requiring constant human supervision, the information if there are and to which extent differences between early, middle and late hatched larvae might be rather useful for producers.

Another technological phase in sturgeon aquaculture, which might be the most critical for farms, is juvenile production. Likewise, this production phase largely modifies the success of further breeding.

The economic feasibility of sturgeon production in national farms can be most certainly increased via technological improvements. Nevertheless, another possibility for yield increment might be in usage of new species/subspecies. Based on our preliminary experiences the growth potential of Siberian sterlet subspecies (*Acipenser ruthenus marsiglii*) is equal or even higher compared to indigenous “Danube” sterlet subspecies (*A. ruthenus ruthenus*). These findings are additionally supported with my results on the hybrid between these two subspecies.

1.2. The aim of the study

The aim of my work was to find new or novel solutions for the mentioned production phases and to compare their effectiveness with already existing methods and with it contribute to sturgeons breeding, before all to the development of artificial reproduction and juvenile production of sterlet. In order to reach it, I set the following experimental goals:

1. Test the effect of three different egg de-adhesion solutions on the fertilisation and hatching. Further on, examine two mentioned fertilisation methods and their effect on fertilisation and further development until hatching.
2. Assess the differences in the larviculture performance in larvae hatched at different time.
3. Determine the optimal weaning time and method for sterlet larvae examining the effect on further development through two consecutive trials.
4. Assess the production potential of new species for domestic farmers, Siberian sterlet and compare the production parameters in closed intensive systems with Danube sterlet with respect to weaning to dry diets, production performance relation to rearing temperature as well as the juvenile growth performance.

2. Own examinations

2.1. Materials and methods

2.1.1. Experimental conditions

Experimental fish used in our trials were originating from the live gen-bank of Research Institute for Fisheries and Irrigation in Szarvas, while the experimental work took place in the recirculation facility of the institute.

In order to perform artificial reproduction, breeders stocked in tank were warmed up to $16,0 \pm 0,5$ °C by paste 2 °C day^{-1} . Final gonadal maturation was induced three days later using a single dose of synthetic gonadotropin releasing hormone analogue (Gonazon; Intervet International BV, Boxmeer, The Netherlands). The used dosage for females was 40 $\mu\text{g kg}^{-1}$ bodyweight, while for males it was 20 $\mu\text{g kg}^{-1}$. Females were stripped using a method explained by PODUSHKA (1999) where the incision was made on the oviduct part close to genital papilla. Prior to fertilization, sperm was diluted in clean water in ratio 1:200 in order to prevent polyspermy (DETTLAFF et al., 1993). Except in the trial targeting the fertilisation method, eggs were fertilised using semi-dry method, while the adhesiveness of the eggs was eliminated using solution of cow milk in water (7 L water + 1 L milk of 3.5% fat content). Fertilised eggs were further incubated in Zug jars on temperature $19,1 \pm 0,9$ °C. The incubation and hatching technological solutions usually applied for sturgeon were applied. Hatching of larvae took place five to eight days upon fertilisation.

The chemical water quality parameters as well as temperature (20-22 °C) during the rearing trials were kept within the optimal range for sturgeons (CHEBANOV and GALICH, 2013). For measurements of individual body weight and length we measured 30-30 and 50-50 fish per tanks, in case of larvae and older classes, respectively. At the end of trials, as well as during the trials with advanced fingerlings, all juveniles were measured individually.

Survival rate (S) was calculated based on the difference in number of juveniles at the beginning and at the end of trial period. These values are given in a form of percentage (%). The growth of each stock during the trial period was presented as harvested yield (Y) presenting the total harvested biomass in a volume of rearing unit (g L^{-1}). Additionally, depending on the suitability for the given trial, we calculated following parameters based on the literature sources: specific growth rate (SGR), condition factor

(CF), feed conversion rate (FCR) and coefficient of variation for individual body weight (CV_0 and CV_t), as well as its changes during the trial duration (CV_t/CV_0).

To compare the fertilisation and hatching rate, I used Chi² test. Prior to statistical analysis, survival rate values in percent were arcsin transformed. For the rearing trials on juveniles and fingerlings, normal distribution was checked using one sample Kolmogorov-Smirnov test. Further on, one-way analysis of variance (one-way ANOVA, SPSS 13.0 for Windows) was used to assess the differences between the treatment groups and after LSD post-hoc test. To evaluate the relationship between the temperature and growth potential of two subspecies I used initially two-way analysis of variance (two-way MANOVA, SPSS 13.0 for Windows). Further on, I performed Tukey's post-hoc.

2.1.2. Specific experimental conditions

2.1.2.1. Egg de-adhesion

Due to work arranging reasons and logistical considerations, the trial was performed using the eggs of Siberian sturgeon (*Acipenser baeri*). Within the trial two fertilisation methods and three different solutions for the egg adhesiveness elimination were tested in duplication. Initially two fertilisation methods were performed, wet (prior to fertilisation eggs were washed in clean water) and semi-dry (ovarian fluid was siphoned from the eggs with syringe), while consecutively the below egg de-adhesion solutions were used:

1. T treatment: cow-milk solution (7 liters of water + 1 litre cow-milk with 3.5 % fat content)
2. K treatment: starch solution (10 liters of water + 5 kg potato-starch)
3. W treatment: Woynárovich II. solution (10 liters water + 40 g NaCl + 160 g urea, after 3 x 20 minutes stirring 0,25 ppt tannic acid-solution treatment)(WOYNÁROVICH and WOYNÁROVICH, 1980).

In case of all three methods, washing solution was refreshed each 15-20 minutes ensuring the appropriate temperature and oxygen level. At the stage of visible spine development (about 60 hours upon fertilisation), a random sample of 200-300 eggs was taken from each replication in order to assess the fertilisation rate. The fertilised eggs were divided with total number of evaluated eggs and further fertilisation rate was shown in percentage form. In order to assess the hatching rate, upon initiation of hatching, samples of eggs were divided in 20 L bowls and among the fertilised eggs, swimming hatched larvae were

harvested and counted. The hatched larvae were divided with the total number of eggs separated in the hatching bowls and likewise presented in percent form.

2.1.2.2. Weaning to dry diets

The present trial was performed using the Danube sterlet subspecies (ARR) and the gametes from one female and one male were used to produce the larvae material for the trial (RÓNYAI, 2009). Four days post-hatch (mean individual bodyweight 12.8 ± 1.3 mg) 1440 larvae were randomly divided into twelve 40 L volume plastic tanks making the stocking density at 15 larvae per litre. Larvae were offered feed starting from 4 day post-hatch (DPH) with *Tubifex* worms in five meals per day, and exogenous feeding started at 7 DPH. At that moment, trial was started where the first phase -weaning - was evaluated until 26 DPH while the second phase - rearing - lasted until 53 DPH.

During the weaning phase six different feed habituation methods (WS) were tested in duplicates (**Figure 1**). The experimental diets were Perla larva proactive 3.0 (0.4-0.8 mm) and Perla larva proactive 5.0 (0.2-0.4 mm) (Skretting, Hendrix Spa, Mozzecane, Italy). The difference among the habituation treatments were in progress dynamics in dry feed ratio and used diets pellet size.

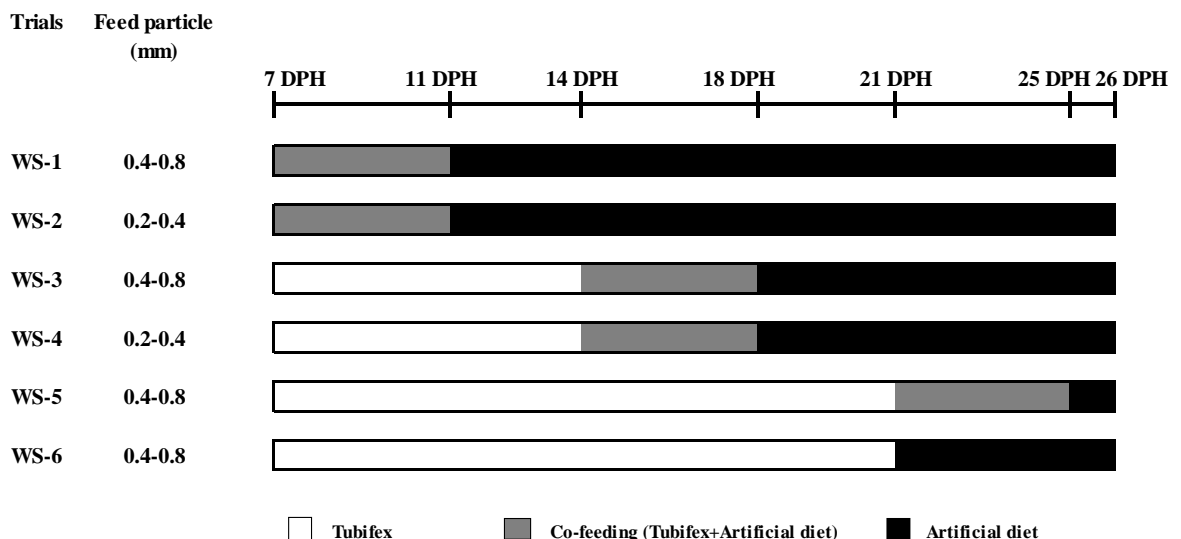


Figure 1.: Weaning strategies

The habituation period was finished at 26 DPH and all larvae were counted, measured for individual weight and stocked into 250 L volume round tanks. Following period lasted 27 days during which the juveniles were fed with catfish feed of pellet size 0.8-1.2 mm (Haltáp Kft., Szarvas).

For the second trial, we used the Siberian subspecies of sterlet (ARM). The 5 DPH larvae (mean individual bodyweight 16.05 ± 1.3 mg) 900 individuals were randomly divided into nine 40 L plastic tanks presenting three triplicated treatments. Thus, 100 larvae were stocked in each tank resulting in stocking density of 2.5 larvae per litre. The trial duration was 25 days where the first live food (Tubifex worms cut in small pieces) and dry diet (Fry crumbs 000; pellet size 0.3 – 0.5 mm; protein: 58%, fat: 12%; Joosen-Luycxk Aqua Bio, Turnhout, Belgium) were offered in *ad libitum* manner to fish in three daily meals.

Three different weaning methods were compared in the present trial: 1) fish were fed dry feed exclusively since the start of the trial; 2) after initial five days of feeding with live food, fish were suddenly weaned to dry diet without co-feeding; and 3) after initial five days feeding with live food fish were gradually weaned to dry diet in four days during which the live food meals were reduced while the dry feed was increased in gradual manner.

2.1.2.3. Effects of hatching time on production performances of sterlet

The larvae of Siberian sterlet used for this study were obtained in seasonal March propagation. The eggs of four females were stocked in separate Zug jars. At the beginning of hatching 100 larvae were harvested from each Jar and further stocked in separate tanks. In the same manner, 12 and 24 hours after initial sampling, two more samples were made. On this way, three different experimental groups were formed. According to the hatching time, the groups were named: early (E), middle (M) and late (L) hatch. In this manner 210 larvae were stocked in nine tanks for each triplicated group making 70 larvae per 15 L volume plastic tank (2.5 larvae per litre).

The feeding started at 5 DPH. During the 20 days long trial both live food (chopped Tubifex) and dry feed (Skretting Larva Proactive 5.0) were offer in *ad libitum* manner in three daily meals. Live food exclusively was given during the first five days, followed with four days of gradual weaning onto dry diet.

2.1.2.4. Comparison of production performance parameters of Danube and Siberian subspecies of sterlet

Two subspecies of sterlet, ARR and ARM, were used for trial on comparison of production potential aiming to describe dry feed habituation, relationship of growth parameters and temperature as well as growth potential of advanced fingerlings. As described earlier, gradual weaning method was used in 300 larvae of both subspecies (mean individual bodyweight 12.55 ± 1.26 mg and 16.05 ± 1.3 mg for ARR and ARM, respectively).

To assess the effect of temperature 450 individuals of each subspecies (mean individual bodyweight 1.58 ± 0.15 mg and 1.37 ± 0.06 mg for ARM and ARR, respectively) were used. At each temperature (20, 23 and 26 °C) for both subspecies triplicated groups of 50 individuals per replication were stocked in cage. The useful volume of each cage was about 50 L resulting stocking density at one juvenile per litre. After 21 days of rearing, the cages became too small with respect to fish growth, therefore the number of individuals per cage was reduced to 30. For the entire 35 days of trial sterlets were fed at feeding rate of 7 % of actual biomass. The juveniles were hand fed with Perla larva proactive 3.0 (Skretting) in five daily meals. Inside the tanks, the rearing water temperature was kept stable with total deviation of ± 0.5 °C. The chemical properties of the rearing water were equal among the experimental tanks.

For the trial on advanced fingerlings we used in total 45 juveniles (mean individual bodyweight 105.2 ± 1.5 g and 104.5 ± 1.5 g for ARM and ARR, respectively) per each subspecies where 15 pieces were stocked per triplicated 250 L round tank in each group. For the whole trial period of 29 days, sterlets were fed at daily rate 3% of actual biomass with Aller Bronze dry feed with pellet size 2.1-3.0 mm.

2.2. Results

2.2.1. I proved that wet fertilisation method is more effective than semi-dry in sturgeons. Rinsing the eggs with water prior to fertilisation, i.e. wet fertilisation method, had a positive effect on fertilisation rate, especially in case of second female (**Table 1.**). Thus, using this method, inhibitory effect of ovarian fluid can be reduced.

Table 1.: Effects of different fertilisation and de-adhesion methods on hatching and fertilisation rates*

	Wet fertilisation			Semi-dry fertilisation		
	T	K	W	T	K	W
Fertilisation rate (%)						
Female 1.	89.55 ^a	79.66 ^{ab}	79.54 ^{ab}	66.67 ^b	79.03 ^{ab}	76.47 ^b
Female 2.	85.89 ^a	88.75 ^a	87.69 ^a	61.53 ^b	69.11 ^b	66.67 ^b
Hatching						
rate	95.40 ^{bc}	98.21 ^c	93.95 ^{bc}	98.46 ^c	85.85 ^a	90.90 ^{ab}
(%) **						

* Different letters show the significant difference between the treatments. Chi-value = 11.35; freedom level = 5 ($P < 0.05$; $\chi^2_{crit.} = 11.1$).

** The hatching rates were examined only in case of Female 1.

Where T – milk solution, K – starch solution, W – Woynárovich II. solution.

2.2.2. I found that all assessed methods for egg de-adhesion, milk (T), starch (K) as well as Woynárovich method (W) were all effective in adhesiveness elimination, however the latter treatment, which uses tannic acid significantly prolongs the hatching of larvae. The needed time to eliminated adhesiveness was 40 minutes in T treatment, while in case of K and W treatments it took 60 minutes. Hatching occurred between 84-122 hours post-fertilisation in T treatments, while in case of K and W treatments it lasted 86-126 and 89-144 hours post-fertilisation, respectively. The shortest and at the same time the most synchronized hatching was observed in T treatments, followed by K and further on W treatment (**Figure 2.**).

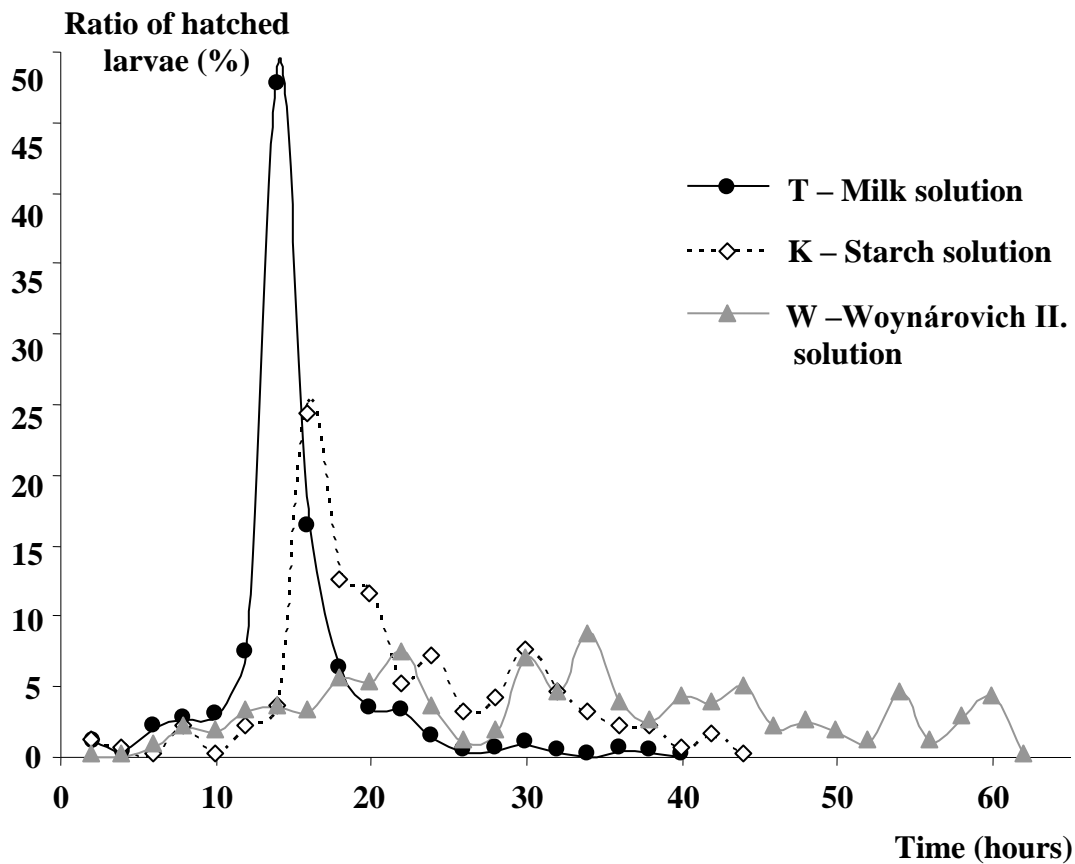


Figure 2.: Effects of different egg de-adhesion methods on the process of hatching

2.2.3. I found that the weaning from live food to dry diet in period 14-21 DPH can be recommended as it led to favourable survival and production parameters (**Table 2.**). However, in means of weaning strategy (gradual or sudden) significant effect was not visible (**Tables 2. and 3.**). With respect to suitability of starter feed pellet size for sterlet larvae it can be stated that smaller fraction 0.2 - 0.4 mm leads to higher survival rate, while the size 0.4-0.8 mm improved the growth. Thus, in terms of harvested yield the effect of different pellet size was not significant (**Table 2.**). Based on the achieved results, it can be stated that the weaning method applied did not affect the performance of juvenile sterlets during the following rearing phase.

Table 2.: Production parameters of 26 DPH sterlets

Treat-ments	S (%)	w (g)	SGR (% day ⁻¹)	Y (g L ⁻¹)	CV_t (%)
WS-1	36.0 ± 6.2 ^a	0.95 ± 0.01 ^c	18.7 ± 0.0 ^c	5.30 ± 0.88 ^a	35.9 ± 0.2 ^a
WS-2	50.0 ± 0.2 ^b	0.63 ± 0.02 ^a	16.6 ± 0.2 ^a	4.85 ± 0.15 ^a	34.9 ± 1.4 ^a
WS-3	76.1 ± 10.7 ^c	0.99 ± 0.02 ^c	18.9 ± 0.1 ^c	11.71 ± 1.91 ^c	36.1 ± 1.4 ^a
WS-4	81.3 ± 3.7 ^{cd}	0.68 ± 0.03 ^a	17.0 ± 0.2 ^a	8.56 ± 0.05 ^b	34.5 ± 2.1 ^a
WS-5	89.9 ± 1.3 ^d	0.82 ± 0.07 ^b	17.9 ± 0.4 ^b	11.41 ± 1.12 ^c	33.7 ± 1.8 ^a
WS-6	80.2 ± 0.7 ^{cd}	0.89 ± 0.06 ^b	18.3 ± 0.4 ^{bc}	10.99 ± 0.89 ^{bc}	35.3 ± 3.4 ^a

Values within column with different superscripts are significantly different ($P \leq 0.05$). Values of standard deviations mean for duplicates.

Where S – survival rate, w_t – individual final bodyweight, SGR – specific growth rate, Y – harvested yield, CV_t – the final coefficient of variation of final bodyweights.

2.2.4. I confirmed the previous observations that although the sterlet larvae are capable of dry feed digestion straight at the initiation of exogenous feeding, for the proper survival and later development several days of live food supplementation is necessary (**Table 3.**).

Table 3.: Effects of three different weaning methods on production performance of Siberian sterlet

	S (%)	w_t (g)	l_t (mm)	CF (%)	SGR (% day ⁻¹)	Y (g L ⁻¹)
Gradual weaning	66.7 ± 17.9 ^a	0.61 ± 0.12 ^a	50.6 ± 4.7 ^a	0.47 ± 0.03 ^a	14.5 ± 0.7 ^a	0.90 ± 0.08 ^a
Sudden weaning	59.6 ± 11.1 ^a	0.58 ± 0.07 ^a	49.1 ± 2.0 ^a	0.48 ± 0.02 ^a	14.3 ± 0.5 ^a	0.82 ± 0.13 ^a
Exclusively dry feed	48.1 ± 5.8 ^a	0.20 ± 0.01 ^b	35.3 ± 2.0 ^b	0.49 ± 0.01 ^a	10.1 ± 0.1 ^b	0.23 ± 0.03 ^b

Values within column with different superscripts are significantly different ($P \leq 0.05$).

Where S – survival rate, w_t – individual final bodyweight, l_t – individual final length, CF – condition factor, SGR – specific growth rate, Y – harvested yield.

2.2.5. Based on the achieved results I found that the early hatched larvae are characterized by significantly reduced viability compared to their 12 and 24 h later hatched siblings. Likewise, I proved that later rearing performance in sterlet juveniles was not affected by hatching time (**Table 4.**).

Table 4.: Effects of different hatching times on production performance of sterlet

	S (%)	w_t (g)	CV_t CV₀⁻¹ (% % ⁻¹)	CF (%)	SGR (% day ⁻¹)	Y (g L ⁻¹)
Early hatch (E)	30.5±8.1 ^a	0.31±0.04 ^a	2.7±0.4 ^a	0.50±0.04 ^a	16.0±0.7 ^a	0.16±0.03 ^a
Medium hatch (M)	39.0±6.8 ^{ab}	0.35±0.03 ^a	4.8±0.4 ^b	0.48±0.03 ^a	16.5±0.4 ^a	0.24±0.03 ^b
Late hatch (L)	49.5±0.8 ^b	0.34±0.04 ^a	6.0±1.1 ^b	0.46±0.02 ^a	16.0±0.6 ^a	0.30±0.04 ^b

Values within column with different superscripts are significantly different ($P \leq 0.05$). Where S – survival rate, w_t – individual final bodyweight, CV_t CV₀⁻¹ – the ratio of the final and initial coefficient of variation, CF – condition factor, SGR – specific growth rate, Y – harvested yield.

2.2.6. Evaluating the results on weaning success in Danube and Siberian sterlet subspecies I found that the latter is characterized with lower mortalities. Besides the reduced harvested yield in Danube subspecies caused by lower survival rate, it can be stated that the production parameters did not significantly differ in these two subspecies during the initial larviculture phase (**Table 5.**).

Table 5.: Production parameters of sterlet subspecies

Sterlet subsp.	S (%)	w_t (g)	l_t (mm)	CF (%)	SGR (% day ⁻¹)	Y (g L ⁻¹)
Danube (ARR)	35.4±11.2 ^a	0.65±0.02 ^a	54.1±4.0 ^a	0.47±0.03 ^a	15.8±0.1 ^a	0.54±0.18 ^a
Siberian (ARM)	66.7±14.9 ^b	0.61±0.12 ^a	50.6±4.7 ^a	0.47±0.03 ^a	14.5±0.7 ^b	0.90±0.08 ^b

Values within column with different superscripts are significantly different ($P \leq 0.05$). Where S – survival rate, w_t – individual final bodyweight, l_t – individual final length, CF – condition factor, SGR – specific growth rate, Y – harvested yield.

I was able to clearly show that the optimal rearing water temperature for both subspecies is 23 °C as on this temperature fish were characterized with the best growth parameters and lowest feed conversion rate (**Table 6.**).

Table 6.: Values of production parameters of sterlet depending on the three different rearing temperatures

T (°C)	w_t (g)	SGR (% day ⁻¹)	FCR (% % ⁻¹)	Y (g L ⁻¹)
20	18.36 ± 1.23 ^a	7.3 ± 0.3 ^{ab}	0.99 ± 0.07 ^{ab}	11.01 ± 0.74 ^a
23	20.79 ± 1.01 ^b	7.6 ± 0.3 ^b	0.94 ± 0.06 ^a	12.47 ± 0.61 ^b
26	18.87 ± 2.43 ^{ab}	7.2 ± 0.2 ^a	1.05 ± 0.07 ^b	11.32 ± 1.46 ^{ab}

Values within column with different superscripts are significantly different ($P \leq 0.05$; $n = 180$). Values of standard deviations mean for triplicates.

Where w_t – individual final bodyweights, SGR – specific growth rate, FCR – feed conversion rate, Y – harvested yield.

Between the growth rates and feed conversion of the two subspecies significant differences were detected. The values of Danube subspecies (ARR) were significantly better than the Siberian one (ARM) in both parameters (**Table 7.**).

Table 7.: Values of production parameters of sterlet depending on the effects of subspecies

Subspecies	w_t (g)	SGR (% day ⁻¹)	FCR (% % ⁻¹)	Y (g L ⁻¹)
Siberian (ARM)	19.85 ± 2.02 ^a	7.2 ± 0.2 ^a	1.04 ± 0.05 ^b	11.91 ± 1.21 ^a
Danube (ARR)	18.83 ± 1.76 ^a	7.5 ± 0.3 ^b	0.95 ± 0.07 ^a	11.30 ± 1.06 ^a

Values within column with different superscripts are significantly different ($P \leq 0.05$; $n = 270$). Values of standard deviations mean for triplicates.

Where w_t – individual final bodyweights, SGR – specific growth rate, FCR – feed conversion rate, Y – harvested yield.

Although without statistical significance, the production parameters in Siberian subspecies were more favourable than in Danube subspecies during the trial on rearing of advanced juveniles (**Table 8.**).

Table 8.: Production parameters of sterlet subspecies at the end of 29 days long nursing phase

Sterlet subsp.	w_t (g)	l_t (mm)	CF (%)	SGR (% day⁻¹)	FCR (% %⁻¹)
Siberian (ARM)	161.1 ± 13.30 ^a	32.6 ± 0.8 ^a	0.44 ± 0.02 ^a	1.5 ± 0.3 ^a	1.72 ± 0.32 ^a
Danube (ARR)	148.4 ± 8.42 ^a	32.4 ± 1.1 ^a	0.44 ± 0.02 ^a	1.2 ± 0.2 ^a	2.00 ± 0.30 ^a

Values within column with different superscripts are significantly different ($P \leq 0.05$). Where w_t – individual final bodyweight, l_t – individual final length, CF – condition factor, SGR – specific growth rate, FCR – feed conversion rate.

Based on the experiences gained during the comparison trials on the two sterlet subspecies I find it plausible to state that aptness for intensive rearing of Siberian subspecies is at least similar, but perhaps better than Danube subspecies.

3. New scientific results

1. It was proven that in the case of genuine sturgeon the efficiency of the wet fertilization method exceeds that of the semi-dry method (fertilization rate in female 2.: 87.44% vs. 65.77%; ($P \leq 0.05$)). Rinsing the freshly stripped eggs with clean water before fertilization, the inhibiting effect of the ovarian fluid on the fertilization can be diminished.
2. It was found that eggs treated for egg adhesiveness elimination with “Woynárovich” method, hatch later (89-144 hours post-fertilization) than in case of milk- (84-122 hours post-fertilization) or starch-solution (86-126 hours post-fertilization) treated eggs.
3. It was proven that sterlet larvae can ingest and digest the dry feed at the beginning of exogenous feeding, however for an appropriate survival rate (66.7 and 59.6 vs. 48.1%; ($P \leq 0.05$)) and later healthy development it requires several days period of feeding with live food.
4. It was recommended that weaning of sterlet larvae from live to dry diets takes place in period 14-21 days post-hatch (DPH). In such case a greater survival (7-DPH-weaned - 36%, vs. 14- and 21-DPH-weaned - 76.1% and 89.9%, respectively; ($P \leq 0.05$)) and production parameters (yield in 7-DPH-weaned 5.30 g L⁻¹ vs. 14-DPH- and 21-DPH-weaned 11.71 g L⁻¹ and 11.41 g L⁻¹, respectively; ($P \leq 0.05$)).
5. Regarding the particle size of starter feeds with the same content used for feeding sterlet larvae, it can be stated that the use of the 0.2-0.4 mm size leads to a better survival rate compared to 0.4-0.8 mm (50.0 % vs. 36.0 % and 81.3 vs. 76.1%; ($P \leq 0.05$)). On the other hand, a greater mean weight (0.95 g vs. 0.63 g and 0.99 g vs. 0.68 g; ($P \leq 0.05$)) was observed using the 0.4-0.8 mm size. However, in terms of harvest yield, there was no effect of feed particle size.

6. According to the obtained results, it was found that the survival rate of earlier hatched larvae (30.5%) is significantly lower than that of their siblings hatched 12 hours and 24 hours later (39.0% and 49.5%, respectively; $P \leq 0.05$). Likewise, I demonstrated that the time of hatching has no significant effect on the subsequent production parameters of sterlet larvae.
7. It was found that the Siberian subspecies can be weaned to dry food with lower mortality than the Danube subspecies (66.7% vs. 35.4% survival; $P \leq 0.05$). It can also be stated that the other production indicators of the two subspecies do not differ significantly at this initial stage of rearing.
8. It was demonstrated that the most favourable rearing temperature for both sterlet subspecies is 23 ° C, as both the growth rate (7.55 % day⁻¹ SGR) and the feed utilization (0.94 g g⁻¹ FCR) were the most favourable on this temperature. Both other tested temperatures of 20 ° C and 26 ° C led to inferior results (7.33% day⁻¹ and 7.17 % day⁻¹ SGR and 0.99 g g⁻¹ and 1.05 g g⁻¹ FCR, respectively; $P \leq 0.05$).

4. Practical applicability of the results

During the sturgeon intensive rearing, including sterlet, there are still certain issues which can be troublesome even for experienced professionals and artificial reproduction and juvenile production are among the two most crucial technological processes. The aim of my work was to find the novel solutions and to compare the effectiveness of those methods already existing for these critical phases needing higher attention.

1. The results of my trials clearly demonstrate the advantages of wet fertilisation method over the semi-dry method. Using this technique increases the fertilisation rate, which can lead to reduction in broodstock numbers needed for artificial reproduction and/or reducing the additional costs in this technological phase.
2. In my trial I assessed the efficacy of three egg de-adhesion methods more or less known in practice. Both cow milk and starch solutions can be advised from practical point as these are effective methods for adhesiveness elimination, simple to use and relatively cheap methods. Likewise, the Woynárovich method usually used for cyprinids I do not recommend as it can lead adverse outcome.
3. The live food is necessary for sterlet larvae from the start of the exogenous feeding and weaning should be initiated between 14-21 DPH. The producers' recommendations for juvenile fish are already provided from aspects of physical features and crude composition, nevertheless for the best performance it is necessary to define the species specific optimal pellet size. During the weaning of sterlet larvae it is advised to feed with smaller particle feeds 0.2-0.4 mm and 4-5 days upon completed weaning to shift to bigger pellet size range of 0.4-0.8 mm. Using of this feeding protocol ensures favourable growth and survival thus increasing the efficacy of juvenile production minimizing the invested time, costs and energy.
4. Depending on the water temperature, hatching of sterlet larvae can take even days. The early hatched larvae are characterized by reduced viability compared to 12 and 24 hours later hatched siblings. It is practical to separate the larvae hatched at the early stage in order to prevent the possible future infections and diseases.

5. Besides refinement of rearing technologies and introduction of new methods, it is possible to improve the production efficiency through introduction of new stocks with different genetic background and perhaps different biological and environmental requirements than the line thus far used. My trials on comparison of Danube and Siberian sterlet subspecies showed that the latter is of higher viability in closed intensive production system. Consumption size can be reached faster in Siberian subspecies improving economical efficacy of production especially in farms with more favourable water rearing temperatures. To better determine the optimal range of this crucial rearing parameter, I find necessary additional experiments on semi-commercial level.

5. References

1. BRONZI, P. – ROSENTHAL, H. – GESSNER, J. (2011): Global sturgeon aquaculture production: an overview. *Journal of Applied Ichthyology* 27: 169-175.
2. CHEBANOV, M. S. – GALICH, E.V. (2013): *Sturgeon Hatchery Manual*. FAO, Ankara, 2013. ISBN: 978-92-5-106823-6.
3. DETTLAFF, T. A. – GINSBURG, A. S. – SCHMALHAUSEN, O. I. (1993): *Sturgeon fishes: developmental biology and aquaculture*. Springer-Verlag, Berlin: 300.
4. DOROSHOV, S. I. – CLARK, W. H. Jr. – LUTES, P. B. – SWALLOW, R. L. – BEER, K. E. – MCGUIRE, A. B. – COCHRAN, M. D. (1983): Artificial propagation of the white sturgeon, *Acipenser transmontanus*. *Aquaculture* 32: 93-104.
5. GISBERT, E. – WILLIOT, P. (2002): Advances in the larval rearing of Siberian sturgeon. Review paper. *Journal of Fish Biology* 60: 1071-1092.
6. KOWTAL, G. V. – CLARK, N. H. – CHERR, G. N. (1986): Elimination of adhesiveness in eggs from the white sturgeon, *Acipenser transmontanus*: chemical treatment of fertilized eggs. *Aquaculture* 55: 139-143.
7. PODUSHKA, S. B. (1999): New method to obtain sturgeon eggs. *Journal of Applied Ichthyology* 15: 319.
8. RÓNYAI, A. (2009): The effect of different synthetic gonadotrop-releasing hormone analogues and their combinations with anti-dopaminergic compound on the reproduction performance of sterlet (*Acipenser ruthenus* L.). *Aquaculture Research* 40: 315-322.
9. WILLIOT, P. – SABEAU, L. – GESSNER, J. – ARLATI, G. – BRONZI, P. – GULYAS, T. – BERNI, P. (2001): Sturgeon farming in Western Europe: recent developments and perspectives. *Aquat. Living Resour.* 14: 367-374.
10. WOYNÁROVICH, E. – WOYNÁROVICH, A. (1980): Modified technology for elimination of stickiness of common carp (*Cyprinus carpio*) eggs. *Aquacultura Hungarica (Szarvas) II.*: 19-21.

6. Publications



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Candidate: Tibor Feledi
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List of publications related to the dissertation

Hungarian scientific articles in Hungarian journals (3)

1. **Feledi, T.**, Adorján, Á., Rónyai, A.: A kecsege dunai (*Acipenser ruthenus ruthenus*) és szibériai (*A. r. marsiglii*) alfaja termelési potenciáljának összehasonlítása.
Halászat. 106 (4), 22-24, 2013. ISSN: 0133-1922.
2. **Feledi, T.**, Rónyai, A.: A szibériai kecsege (*Acipenser ruthenus marsiglii*)intenzív rendszerben történőivadékevelésének előzetes eredményei.
Agrártud. közl. 51, 27-31, 2013. ISSN: 1587-1282.
DOI: <https://doi.org/10.34101/actaagrar/51/2057>
3. **Feledi, T.**, Lengyel, S., Rónyai, A.: Egy intraspecifikus kecsegehibrid (szibériai kecsege x kecsege) intenzív rendszerben történő nevelésének előzetes eredményei.
Agrártud. közl. 48, 17-19, 2012. ISSN: 1587-1282.

Foreign language scientific articles in international journals (4)

4. Rónyai, A., **Feledi, T.**: Co-feeding as a weaning procedure in sterlet (*Acipenser ruthenus* L.) larvae.
Aquac. Res. 44, 1489-1491, 2013. ISSN: 1355-557X.
DOI: <http://dx.doi.org/10.1111/j.1365-2109.2012.03167.x>
IF: 1.32
5. Akbulut, B., **Feledi, T.**, Lengyel, S., Rónyai, A.: Effect of feeding rate on growth performance, food utilization and meat yield of sterlet (*Acipenser ruthenus* Linne 1758).
J. FisheriesSciences.com. 7 (4), 215-224, 2013. ISSN: 1307-234X.
DOI: <http://dx.doi.org/10.3153/jfsc.com.2013022>
6. **Feledi, T.**, Rónyai, A.: Preliminary results on Siberian sterlet fry rearing and their comparison with some production performance parameters of "European" sterlet.
J. Fish. Quat. Sci. 13 (3), 551-553, 2013. ISSN: 1303-2712.
DOI: http://dx.doi.org/10.4194/1303-2712-v13_3_20
IF: 0.384





7. **Feledi, T.**, Kucska, B., Rónyai, A.: Effect of different fertilisation and egg de-adhesion methods in artificial propagation of Siberian sturgeon, *Acipenser baeri*.
Arch. Pol. Fish. 19 (2), 119-122, 2011. ISSN: 1230-6428.
DOI: <http://dx.doi.org/10.2478/v10086-011-0014-7>

Hungarian conference proceedings (1)

8. **Feledi, T.**, Lengyel, S., Rónyai, A.: A lapátorru tok (*Polyodon spathula*) és a szibériai kecsege (*Acipenser ruthenus marsiglii*) szaporításának 2011. évi tapasztalatai.
Halászatfejlesztés. 35, 66-70, 2012. ISSN: 1219-4816.

Foreign language conference proceedings (2)

9. **Feledi, T.**, Lengyel, S., Rónyai, A.: Preliminary results on Siberian sterlet (*Acipenser ruthenus marsiglii*) fries rearing.
In: Domestication in finfish aquaculture. Ed.: Dariusz Kucharczyk, Pracownia Wydawnicza "ElSet", Olsztyn, 83-86, 2012. ISBN: 9788362863310
10. **Feledi, T.**, Lengyel, S., Rónyai, A.: Preliminary results of intraspecific sterlet hybrid (Siberian sterlet x Sterlet) rearing under intensive conditions.
In: Aquaculture in Central and Eastern Europe: present and future : The II. Assembly NACEE and the Workshop on the Role of Aquaculture in Rural Development, Pontos, Kishinev, 274-276, 2011. ISBN: 9789975512930

Hungarian abstracts (2)

11. **Feledi, T.**, Lengyel, S., Rónyai, A.: Egy intraspecifikus kecsege hibrid (szibériai kecsege x kecsege) intenzív rendszerben történő nevelésének tapasztalatai.
In: XXXVI. Halászati Tudományos Tanácskozás : Szarvas, 2012. május 23-24, Halászati és Öntözési Kutatóintézet, Szarvas, 39, 2012, (ISSN 0230-8312)
12. **Feledi, T.**, Lengyel, S., Rónyai, A.: A lapátorru tok (*Polyodon spathula*) és a szibériai kecsege (*Acipenser ruthenus marsiglii*) szaporításának 2011. évi tapasztalatai.
In: XXXV. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 34, 2011, (ISSN 0230-8312)

Foreign language abstracts (3)

13. **Feledi, T.**, Rónyai, A.: Comparison of the production potential of Siberian and Danube sterlet in recirculating aquaculture conditions.
In: 7th International Symposium on Sturgeons : Book of abstracts, [s.n.], [Nanaimo], 257, 2013.
14. **Feledi, T.**, Rónyai, A.: Preliminary data on the production performance of Siberian sterlet (*Acipenser ruthenus marsiglii*).
In: 7th International Symposium on Sturgeons : Book of abstracts, [s.n.], [Nanaimo], 258, 2013.





15. **Feledi, T.**, Lengyel, S., Rónyai, A.: Preliminary results on Siberian sterlet (*Acipenser ruthenus marsiglii*) fries rearing.
In: Domestication in finfish aquaculture. Ed.: Dariusz Kucharczyk, Pracownia Wydawnicza "ElSet", Olsztyn, 44, 2012. ISBN: 9788362863310

List of other publications

Hungarian scientific articles in Hungarian journals (3)

16. Adorján, Á., Jakabné Sándor, Z., **Feledi, T.**, Percze, V., Nagy, Z., Ardó, L., Dankó, I., Csengeri, I., Rónyai, A.: Növényi összetevőket tartalmazó utónevelő pontytáp tesztelése tavi termelésben.
Halászat. 107 (3), 22-28, 2014. ISSN: 0133-1922.
17. Csengeri, I., Gál, D., Kosáros, T., Pekár, F., Bakos, J., Potra, F., Kovács, G., **Feledi, T.**, Fazekas, J., Biró, J., Jakabné Sándor, Z.: A haltakarmányozás halliszt és halolaj nélkül?
Állatteny. takarm. 60 (3), 277-290, 2011. ISSN: 0230-1814.
18. **Feledi, T.**, Kucska, B., Rónyai, A.: A lapátorrú tok mesterséges szaporításának és előnevelésének hazai tapasztalatai.
Halászat. 103 (1), 20-24, 2010. ISSN: 0133-1922.

Foreign language scientific articles in Hungarian journals (1)

19. Kucska, B., **Feledi, T.**, Adorján, Á., Molnár, T.: The effects of three commercial diets differing in protein and energy ratios on product quality of pike (*Esox lucius*).
Acta Aliment. 45 (1), 112-118, 2016. ISSN: 0139-3006.
DOI: <https://doi.org/10.1556/066.2016.45.1.14>
IF: 0.357

Foreign language scientific articles in international journals (4)

20. Ljubobratović, U., Csengeri, I., Kucska, B., Balogh, E., Lengyel, S., Kovács, G., Adorján, Á., **Feledi, T.**, Janurik, E., Rónyai, A.: Comparison of the Procedures for Adhesiveness Removal in Pikeperch (*Sander lucioperca*) Eggs with Special Emphasis on the Effect of Tannic Acid.
J. Fish. Quat. Sci. 17 (3), 461-469, 2017. ISSN: 1303-2712.
DOI: http://dx.doi.org/10.4194/1303-2712-v17_3_02
IF: 0.482





21. Ljubobratović, U., Kucska, B., **Feledi, T.**, Poleksić, V., Marković, Z., Lenhardt, M., Péteri, A., Kumar, S., Rónyai, A.: Effect of Weaning Strategies on Growth and Survival of Pikeperch, Sander lucioperca, Larvae.
J. Fish. Quat. Sci. 15 (2), 327-333, 2015. ISSN: 1303-2712.
DOI: https://www.doi.org/10.4194/1303-2712-v15_2_15
IF: 0.553
22. Treasurer, J., **Feledi, T.**: The physical Condition and Welfare of Five Species of Wild-caught Wrasse Stocked under Aquaculture Conditions and when Stocked in Atlantic Salmon, *Salmo salar*, Production Cages.
J. World Aquacult. Soc. 45 (2), 213-219, 2014. ISSN: 0893-8849.
DOI: <https://doi.org/10.1111/jwas.12099>
IF: 0.732
23. **Feledi, T.**, Gyalog, G., Rónyai, A., Váradi, L.: Hungary for Success: Casting an eye on Eastern Europe.
Fish Farmer Magazine 36 (1), 16-19, 2013.

Other journal articles (1)

24. **Feledi, T.**: A viza első sikeres szaporítása Magyarországon.
Halászat. 108 (1), 10, 2015. ISSN: 0133-1922.

Hungarian conference proceedings (1)

25. **Feledi, T.**, Lengyel, S., Rónyai, A.: Négy különböző összetételű táp alkalmazásának hatása a barramundi (*Lates calcalifer*) termelési mutatóira.
In: VII. Alföldi Tudományos Tájgazdálkodási Nap : intézeti tudományos diákköri konferencia : 2011. november 17. : Magyar Tudomány Ünnepe : konferenciakiadvány. Szerk.: Barancsi Ágnes, Hernyák Gábor, Szolnoki Főiskola Műszaki és Mezőgazdasági Fakultás, Szolnok, 172-176, 2011. ISBN: 9789638933911

Foreign language conference proceedings (1)

26. Lengyel, S., **Feledi, T.**, Rónyai, A.: Artificial propagation of Eurasian perch (*Perca fluviatilis*) under controlled conditions.
In: 50. Georgikon Napok : jubileumi nemzetközi tudományos konferencia, PE Georgikon Kar, Keszthely, 137-140, 2008. ISBN: 9789639639324(CDROM)

Hungarian abstracts (15)

27. **Feledi, T.**, Dajka, V., Rideg, Á.: A viza (*Huso huso*) első sikeres szaporítása Magyarországon.
In: XXXIX. Halászati Tudományos Tanácskozás Szarvas, 2015. május 20-21. Szerk.: Rónyai András, Nemzeti Agrárkutatási és Innovációs Központ Halászati Kutatóintézet, Szarvas, 11, 2015, (ISSN 0230-8312)





28. Ardó, L., Adorján, Á., **Feledi, T.**, Jakabné Sándor, Z., Rónyai, A., Dankó, I., Csengeri, I., Jeney, G.: Anyahalak takarmányozásának hatása pontylárvák növekedésére és az előnevelt ivadék stressztűrésére.
In: XXXVIII. Halászati Tudományos Tanácskozás Programfüzet : Szarvas 2014. május 28-29, Halászati és Öntözési Kutatóintézet, Szarvas, 32-33, 2014, (ISSN 0230-8312)
29. Jakabné Sándor, Z., Adorján, Á., **Feledi, T.**, Percze, V., Dankó, I., Rónyai, A., Csengeri, I.: Különböző takarmányon nevelt pontyivadékok növekedésének és testösszetételének vizsgálata.
In: XXXVIII. Halászati Tudományos Tanácskozás Programfüzet : Szarvas 2014. május 28-29, Halászati és Öntözési Kutatóintézet, Szarvas, 18-19, 2014, (ISSN 0230-8312)
30. Adorján, Á., **Feledi, T.**, Dankó, I., Biró, J., Jakabné Sándor, Z., Szabó, T., Mészáros, E., Rónyai, A., Csengeri, I.: Zárt rendszerben nevelt ponty anyajelöltek növekedési és reprodukciós paramétereinek értékelése a takarmányozás függvényében.
In: XXXVIII. Halászati Tudományos Tanácskozás Programfüzet : Szarvas 2014. május 28-29, Halászati és Öntözési Kutatóintézet, Szarvas, 16-17, 2014, (ISSN 0230-8312)
31. Csengeri, I., Biró, J., Dankó, I., Jakabné Sándor, Z., **Feledi, T.**, Szabó, T., Rónyai, A.: Esszenciális zsírsav hiány okozta csökkent növekedés és ikratermelés ponty anyajelölteknél.
In: XXXVII. Halászati Tudományos Tanácskozás : Szarvas, 2013. május 23-24, Halászati és Öntözési Kutatóintézet, Szarvas, 70, 2013, (ISSN 0230-8312)
32. Ardó, L., Rónyai, A., **Feledi, T.**, Guojun, Y., Goosen, N. J., de Wet, L., Jeney, G.: Háromféle gyógynövénykivonat hatása a barramundi (*Lates calcarifer*) természetes immunválaszára.
In: XXXVII. Halászati Tudományos Tanácskozás : Szarvas, 2013. május 23-24, Halászati és Öntözési Kutatóintézet, Szarvas, 25, 2013, (ISSN 0230-8312)
33. Ljubobratović, U., Kucska, B., **Feledi, T.**, Péteri, A., Rónyai, A.: Különböző anyagok alkalmazhatósága a süllő (*Sander lucioperca*) ikrák ragadóságának megszüntetésére.
In: XXXVII. Halászati Tudományos Tanácskozás : Szarvas, 2013. május 23-24, Halászati és Öntözési Kutatóintézet, Szarvas, 35, 2013, (ISSN 0230-8312)
34. **Feledi, T.**, Lengyel, S., Rónyai, A.: A barramundi (*Lates calcarifer*) különböző zsírtartalmú tápokkal végzett takarmányozásának eredményei.
In: XXXVI. Halászati Tudományos Tanácskozás : Szarvas, 2012. május 23-24, Halászati és Öntözési Kutatóintézet, Szarvas, 51, 2012, (ISSN 0230-8312)
35. Jakabné Sándor, Z., Csengeri, I., Gyöngyösiné Papp, Z., Biró, J., **Feledi, T.**, Rónyai, A.: Élőtáplálék szervezetek dúsítási technológiájának fejlesztése.
In: XXXVI. Halászati Tudományos Tanácskozás : Szarvas, 2012. május 23-24, Halászati és Öntözési Kutatóintézet, Szarvas, 19, 2012, (ISSN 0230-8312)





36. **Feledi, T.**, Kovács, G., Rónyai, A., Jeney, Z., Jakabné Sándor, Z., Gyöngyösiné Papp, Z., Bakos, J., Csengeri, I.: Három ponty alfaj/fajta (Dunai, Amúri, Szegedi tükrös) növekedése és takarmányhasznosítása különböző zsírsav tartalmú tápok alkalmazásakor.
In: XXXV. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 50, 2011, (ISSN 0230-8312)
37. Csengeri, I., **Feledi, T.**, Kovács, G., Jakabné Sándor, Z., Gyöngyösiné Papp, Z., Bakos, J., Rónyai, A.: Három ponty alfaj/fajta (Dunai, Amúri, Szegedi tükrös) testösszetételének és húsmínőségének alakulása különböző zsírsav tartalmú tápok alkalmazásakor.
In: XXXV. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 51, 2011, (ISSN 0230-8312)
38. Kucska, B., **Feledi, T.**, Rónyai, A.: A lapátorru tok (*Polyodon spathula*) medencés és tavi ketreces nevelésének tapasztalatai.
In: XXXIV. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 13, 2010, (ISSN 0230-8312)
39. **Feledi, T.**, Rónyai, A., Gál, D., Kosáros, T., Pekár, F., Potra, F., Csengeri, I.: Növényi takarmánykiegészítők alkalmazása az intenzív tavi pontytermelésben.
In: XXXIV. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 15-16, 2010, (ISSN 0230-8312)
40. Kucska, B., **Feledi, T.**, Kovács, G., Rónyai, A.: A csuka (*Esox lucius*) előnevelése megvilágított ketrecekben.
In: XXXIII. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 20, 2009, (ISSN 0230-8312)
41. **Feledi, T.**, Borbély, G., Kucska, B., Kovács, G., Rónyai, A.: A hibrid csíkos sügér (*Morone saxatilis* x *M. chrysops*) nevelése recirkulációs és "tó a tóban" rendszerben.
In: XXXIII. Halászati Tudományos Tanácskozás : Kivonatok, Halászati és Öntözési Kutatóintézet, Szarvas, 21-22, 2009, (ISSN 0230-8312)

Foreign language abstracts (12)

42. Ardó, L., Rónyai, A., **Feledi, T.**, Guojun, Y., Jeney, G.: Extract of a Chinese medicinal herb, *Astragalus membranaceus* enhances the non-specific immune response of barramundi (*Lates calcarifer*).
Fish Shellfish Immunol. 34 (6), 1694, 2013. ISSN: 1050-4648.
DOI: <https://doi.org/10.1016/j.fsi.2013.03.175>
43. Rónyai, A., **Feledi, T.**: Results of paddlefish (*Polyodon spathula*) fry rearing on different feeding regimes.
In: 7th International Symposium on Sturgeons : Book of abstracts, [s.n.], [Nanaimo], 256, 2013.





44. **Feledi, T.**, Lengyel, S., Rónyai, A.: The effects of four commercially available dry diets on production performance parameters of Barramundi (*Lates calcarifer*).
In: AQUA 2012 : Global Aquaculture Securing our future : Abstracts, [s.n.], [Prague], 344, 2012.
45. **Feledi, T.**, Lengyel, S., Rónyai, A.: The effects of four feeding rates on production performance parameters of Barramundi (*Lates calcarifer*).
In: AQUA 2012 : Global Aquaculture Securing our future : Abstracts, [s.n.], [Prague], 343, 2012.
46. **Feledi, T.**, Rónyai, A., Gál, D., Kosáros, T., Pekár, F., Csengeri, I.: Application of vegetal feed supplements in intensive common carp production.
In: Second NACEE Conference of Young Researchers : Abstracts. Ed.: Laszlo Varadi, Peter Lengyel, Emese Bekefi, Research Institute for Fisheries, Aquaculture and Irrigation, Szarvas, 42, 2010.
47. Kucska, B., **Feledi, T.**, Rónyai, A., Borbély, G.: Development of a multifunctional fish culture system.
In: Second NACEE Conference of Young Researchers : Abstracts. Ed.: Laszlo Varadi, Peter Lengyel, Emese Bekefi, Research Institute for Fisheries, Aquaculture and Irrigation, Szarvas, 48, 2010.
48. **Feledi, T.**, Rónyai, A., Csengeri, I., Péteri, A., Gyalog, G.: Intensive carp production in ponds.
In: 4th International Freshwater Fishery Conference : Proceeding summary, [s.n.], [Vukovar], 3, 2010.
49. Kucska, B., **Feledi, T.**, Rónyai, A.: Intensive rearing of pike (*Esox lucius*) in illuminated cages.
In: Second NACEE Conference of Young Researchers : Abstracts. Ed.: Laszlo Varadi, Peter Lengyel, Emese Bekefi, Research Institute for Fisheries, Aquaculture and Irrigation, Szarvas, 47, 2010.
50. Kucska, B., **Feledi, T.**, Rónyai, A.: Possibilities of rearing paddlefish (*Polyodon spathula*) fry in protected conditions - Hungarian experiences.
In: Second NACEE Conference of Young Researchers : Abstracts. Ed.: Laszlo Varadi, Peter Lengyel, Emese Bekefi, Research Institute for Fisheries, Aquaculture and Irrigation, Szarvas, 29-30, 2010.
51. **Feledi, T.**, Rónyai, A., Csengeri, I., Péteri, A.: Intensive carp production in ponds.
In: 6th Hungarian-Vietnamese International Conference on Cooperation in Sustainable Animal Production and Aquaculture : Proceedings of the conference, [s.n.], [Gödöllő], 24, 2009.
52. Rónyai, A., **Feledi, T.**, Kucska, B.: Results of cage and tank rearing of paddlefish *Polyodon spathula* Walbaum fry - Hungarian experiences.
In: 6th International Symposium on Sturgeons, [s.n.], [Wuhan], 180-182, 2009.





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53. Lengyel, S., **Feledi, T.**, Rónyai, A.: Artificial propagation of Eurasian perch (*Perca fluviatilis*) under controlled conditions.

In: 50. Jubileumi Georgikon Napok. Szerk.: Palkovics Miklós, Kondorosné Varga Erika, Pintér Gábor, Weiss Miklós, PE Georgikon Kar, Keszthely, 62, 2008. ISBN: 9789639639317

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